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ABSTRACT

The Apple Classroom of Tomorrow (ACOT) project is an attempt to alter the instructional premises of a selected group of seven experimental classrooms in the United States by saturating them with computer technology. A recent proposal submitted to Apple Computer described STAR (Sensible Technology Assessment/Research), which includes both quantitative and qualitative indicators of change, and its implementation in the evaluation of ACOT. A focus for the qualitative engagement with the ACOT phenomenon is spelled out in this paper that is primarily interpretive in nature and theory-driven. While the "transactional" approach to evaluating cognitive development and learning can be used in this context, the research and evaluation efforts would be ordered around a different set of questions than are traditionally asked. ACOT classrooms will produce different kinds of conversations and different kinds of child-to-child interactions and computer-based problem-solving tasks. In addition, one can also observe in ACOT classrooms the complex ways in which the computer has become integrated into the lives of the students beyond the classroom. Thus, more will need to be learned about the social organization of computer-based skills and knowledge in the home, and how this supports (or detracts from) its organization in the school. Finally, there may be important teacher differences brought about by the introduction of computers into the classroom, and issues which will need to be explored include teacher morale, curriculum innovation, and student learning. Such qualitative research will be used to answer a limited set of questions about the social organization and distributed learning in the ACOT environment, and will produce research results which, though of a qualitative nature, will have independent value. (11 references) (EW)

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COMPUTER-INTENSIVE SCHOOL ENVIRONMENTS AND THE REORGANIZATION OF KNOWLEDGE AND LEARNING: A QUALITATIVE ASSESSMENT OF APPLE COMPUTER'S CLASSROOM OF TOMORROW

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Introduction

The Apple Classroom of Tomorrow (ACOT) is an attempt to alter the instructional premises of a selected group of seven experimental classrooms in the United States by saturating them with computer technology. Though rich in this technology, ACOT managers regard this as an instructional project rather than a project in technological innovation. It is toward the former that the need for assessment is to be targeted.

After even cursory observation there can be little question that life and instruction in these classrooms have changed. Visits to three of the sites reveal that students enjoy new vocabularies, attend school more regularly, speak of learning and thinking with new metaphors, and speak of themselves with new pride and vigor. Similarly, teachers seem highly motivated, and report trying innovative teaching methods while struggling with new classroom organizations to integrate the computer's "message" with mandated curricula.

Our problem, as social scientists, is, as always, twofold. What changes (and just how permanent or illusory is any change); and, how do we make sense of these changes (or their lack) so as to justify, and properly contextualize, the principled export to other classroom environments of technology-based instructional innovation? In a recent proposal submitted to Apple Computer, Eva Baker and Joan Herman described STAR (Sensible Technology Assessment/Research) and its implementation in the evaluation of the Apple Classroom of Tomorrow (Baker & Herman, 1988). This evaluation effort would be focused on a small number of relatively straightforward questions including ACOT effects on students, teachers, and families, and on the organization and delivery of

instruction. And it would incorporate both qualitative and quantitative indicators of change in a user-sensitive evaluation.

My purpose in this paper is to discuss one major theoretical perspective which might give direction to the analysis of at least a portion of the qualitative materials. I also wish to suggest the related qualitative data collection strategies which could be included within the STAR model and its implementation in the ACOT environment.

Evaluations Using Qualitative Data

The last ten years have seen a dramatic upswing in the interest paid to qualitative data collection procedures and analytic methods. This incorporation of qualitative thinking into educational research and evaluation has not, however, been without controversy. Indeed, it is but a small piece in a much larger drama being played out by both epistemologists and social scientists themselves on the respective ontological status of both qualitative and quantitative paradigms in behavioral research.

One set of authors (Smith & Heshusius, 1986) have convincingly argued that, at least within educational circles, qualitative and quantitative paradigms have evolved from an initial period of mutual disdain to an era of detente and, finally, to the current climate of active cooperation and incorporation. This most recent phase, again soundly argued by Smith and Heshusius, is an invidious one. The reason is that, in the interests of trying to make qualitative procedures more widely accepted, the original (and fundamental) need for an interpretive (or "hermeneutic) way of thinking to capture a reality constructed by social beings (and not pre-existing and waiting for our properly instrumented discovery) has been unthinkingly sacrificed.

What Smith and Heshusius failed to add was that many of the recent studies and evaluations which have employed qualitative

methods have done so in the absence of any real theory. The result is a series of "low-level" observations and descriptions (some systematic, some anecdotal) of various educational settings and programs. Qualitative research and evaluation, then, often suffers from one, or both, of two diseases: either it is good observational work, systematically done, but bereft of organizing theory; or it is good or bad observational work rendered mundane because of a lack of interpretive insight necessary to substantially embody the story that the qualitative data have to tell. In either case, both the research/evaluation effort and the reputation of the qualitative paradigm suffer.

In what follows I would like to spell out a focus for the qualitative engagement with the ACOT phenomenon that is primarily (but not exclusively) interpretive in nature and is theory-driven. It may be observed that this looks more like "science" than it does like "evaluation" as the latter is more typically construed.

The Social Organization of Learning in the Classroom

Much has been made, recently, of the role of others in the cognitive development of the child. Based in varying degrees on the theoretical writings of the late Soviet psychologist L.S. Vygotsky (1978; see also Wertsch, 1985), a number of researchers have pursued what has been called a "transactional" or "socially mediated" approach to cognitive development and learning. The key elements of this approach are that cognition and learning are inherently social phenomena (i.e., between a learner and a more competent other); and that more competent others naturally provide "guided participation" (or "scaffolding") to learners by helping with the harder sub-goals of a task and then pulling back such help with mastery or the pursuit of easier sub-goals. In addition, the transactional approach to learning emphasizes that children are active participants in the learning process who not only put themselves in positions to learn but also actively structure the interaction to facilitate their learning.

A further, related perspective of the transactional approach is that meaningful cognitions occur in the context of everyday problem solving interactions (Rogoff, in press; Fischer and Bullock, 1984; Rogoff and Lave, 1984; Saxe, Gearhart, and Guberman, 1984; Wood, Bruner, and Ross, 1976). For Vygotsky, in fact, learning-in-context is the motive force for cognitive development (Bein, Vlasova, Levina, Morozova, & Shif, n.d.).

In empirical terms the emphasis placed upon everyday events means that the crucial unit of analysis is not a more typical measure of "pure" cognition; but, rather, cognition-in-context. Although there are a variety of formulations of cognition-in-context, all revolve around two key notions. The first is that cognition in everyday settings comes about as a result of meaningful work. The second is that knowledge is socially organized in terms of what are the culturally relevant tasks and the representational systems and other tools individuals have available to them to address these tasks. The analysis of thinking and learning cannot be separated from the analysis of the social organization of meaningful work. To do so, from this transactional point of view, is to rob the study of learning of its very essence: learning and the doing of learning are inseparable; the contexts of thinking and learning are socially organized; and groups, not just individuals, have cognitive properties such that knowledge and cognition are socially distributed.

What does this all have to do with the study of ACOT? If we take a transactional approach to learning in the classroom our research and evaluation efforts must be ordered around a somewhat different set of questions than have traditionally been asked. We would compare ACOT classrooms with non-ACOT groups and ask the following:

> Do the ways in which students "experience" and "produce" knowledge change as a function of their experience in and with the ACOT environment? How is

knowledge organized in this setting? What is important knowledge to have? Is knowledge distributed among groups of students and teachers such that problem solving is externalized in some critical way? What kinds of scaffolding are available to students as they go about trying to master particular skills? Does distributed learning or the presence of multiple scaffolds relate to standard child achievement measures?

Answering these questions requires parallel lines of inquiry. First, we need good observational accounts of how non-ACOT classrooms in the same schools are organized (or, better, ACOT classrooms themselves before they become computer-saturated). Who is credited with having knowledge; who can legitimately impart it to others; how often--and in what ways--does this occur; and what representational form does this knowledge assume? Of course, these are the questions to be asked of the ACOT classrooms; and while the data to address these issues are currently unavailable, initial observations at three of the ACOT schools are of interest.

Even given the variety of computer-use configurations that we observed at the three sites visited, there are students at all sites who are clearly credited as being knowledgable, even as being "experts." At the high school level teachers consult with these student experts, while at the elementary level it is other students who consult. The actual amount of talk about computers and about the problems which co-occur with the computers seems great. Three distinct kinds of "talk" seem to emerge in connection with these ACOT classrooms. First, students begin to form what can only be described as "user's groups." They share observations and opinions about computer components and seek further information. At the Memphis site I had the following conversation initiated by a sixth-grader named Tod:

Tod: Do you have a lot of disks like word processing, language data, and program disks?

HL: What, for my computer?

Tod: Uhhuh.

HL: I have one word processing program.

Tod: That's good.

HL: It's called "Word." On my 2E I use Appleworks.

Tod: Appleworks program?

HL: Yeah.

Tod: Do you have a printer?

HL: I have the same printer you do?

Tod: Oh, OK. My dad said he's thinkin' about gettin' me a printer.

HL: For home?

Tod: Uhhuh, for my computer. Instead of going all through all the trouble of taking all my disks to school. I just could print it out at home, instead of I didn't bring it to school, and then I won't have no trouble. That's why I hope he would.

* * * * * * *

Tod: I like Commodores too.

HL: Do you? I never used one.

Tod: Well my friend got a Commodore, and he got two printers that he's wantin to do some languages to, and all that. It's not as fancy kind of printers, and I like his too. And we do a lot. My friend said he got a modem, and he said he use it all the time for his, 'cause he call up a lot of people. I said, "Have you ever call on the Apple computer?" He say, "Yes." When I talked to him he said he talked to a lot of Apple computers. And I said, "If you talked to a lot of Apple computers, you've probably talked to somebody in our class. At our school." And I say, "I wonder." I don't know yet, though.

Tod gives the impression of being genuinely interested in, and curious about, the world of computers. His final story about his friend's use of a modem is remarkable for its length and detail, but also for Tod's ability to take both sides of the discussion in which he is now re-teaching himself something that his friend has already engaged in dialogue with him about previously. I shall return to this point below.

A second kind of talk among ACOT students appears to be an ability to reflect on the learning process while, at the same time, struggling with their teachers to capture verbally the essence of the new representational system demanded by computers. The following dialogue between a teacher and her students named Clive and Paul, also sixth-graders, is illustrative:

T: Alright, are you learning how to rename?

Pa: Yes.

Cl: See Miss M, (here's the stuff) Here's the stuff you were talking about.

T: That's exactly right, uhhuh. You see the pattern of

the zeros?

Cl: Yes.

T: That's good. How'd you do?

Pa: What, on this?

T: Did you miss it?

Cl: Here's my scores so far.

T: Oh, excellent!

Pa: <Here's my scores>.

Cl: <Here's my scores>.

T: Great.

Cl: Here's my scores. Right here.

T: You're just too smart.

Cl: I'm on the last one now.

T: That's good.

T: What do you think about that? Do you like the graphics that go across the screen?

Cl: Yes.

T: Do you think it's sometimes too slow or does that motivate you?

Cl: Motivate.

T: Motivates you?

T: You like seeing the things that go across the screen?

Cl: Yes.

Cl: But sometimes it take a long time for it to get to the next problem.

T: Does that frustrate you any?

Cl: Uhuh. I just wanted to know why it takes too long.

Both Clive and the teacher have reflected on the pattern displays of a mathematics software program. They are particularly concerned with the speed of the graphics display used to signify to the learner that he/she has answered a problem correctly. Clive, in fact, seems genuinely puzzled that the graphics take so long when he could already be into the next problem. This seems a preliminary step in the child's ultimate self-pacing of his own problem solving routines.

Finally, students seem to spend a great deal of time talking to each other during their actual school work about computer hardware problems and software-based lessons. A sixth-grader named Alan at the Nashville site, for example, kept getting an error-message from his Appleworks program. When asked by the computer whether he wanted this particular outcome, Alan kept pushing "No" but was unable to sequence himself out of the error loop. Alan tried unsuccessfully to get the teacher's attention. As I started to help him another student, from 8 feet away, suddenly walked over, and, in an instant, explained exactly what it was necessary to do. Alan looked up and exclaimed "I've never done that before." When asked if he

could repeat the procedure he said "yes" and then verbally outlined the several steps correctly.

Another example from the Memphis site shows the dialogue between two boys over an error on a math problem:

Cal: Goah {sign of frustration}, it said thirty-six.

Cal: I'm gonna go back on this one.

Jim: I don't know what that is.

Jim: Thirty-six or uh.

Cal: I know.

Jim: Cal, that was easy. <Why couldn't you do that>?

Cal: <I know I had> I put thirty-six. And then that thing had messed it up.

Jim: It probably knew what it was doing.

Cal: No<x>.

Jim: <You know what Miss C.> said about computers last year. Computers don't know much unless you put it inside <the computer>.

Cal: <I put it in>. <I put it in>.

Jim: <Put it inside your computer>. Computer.

Cal: I put thirty-six.

Jim: You can't blame the computer. You might have did

something wrong.

Cal: I didn't. I put thirty-six in it.

Jim: You probably did do something wrong.

Cal: I had to do another one.

Jim: But the computer's different.

Notice in this example that Cal is convinced that his computer is the source of the error. Jim, who doesn't have the skills to be able to offer specific help, nevertheless presents the opposing point of view: that it is human, not computer error, that is the source of the problem. Other students whom we observed were less inept in their helping strategies. Often very specific information about the disk operating system or nuances of the software programs was sought for and obtained.

There is theoretical interest in this cooperative learning/teaching by both educational psychologists and by researchers interested in cognitive development from the transactional point of view. As to the latter, thinking on this topic stems from Vygotsky's (1978) writings on joint performance. Vygotsky conceptualized cognitive development as a two-stage process. In his view, thinking and learning occur first on an inter-psychological (i.e., social) plane and, only subsequently, on an intra-psychological plane. That is, the child is engaged and regulated by more capable others in contextually-specific problem solving situations where strategies are jointly constituted and enacted upon. This dialogue with more capable others, although transformed, becomes internalized and <u>is</u> thinking. Hence, in any study of learning it becomes critical to study how others help (or scaffold) problem solving for less competent others. Additional research into the ACOT classroom would require intensive conversational analyses of child-to-child interactions around computer-based problem-solving tasks.

In addition to potentially quite different kinds of talk which may occur in ACOT classrooms one can also quite easily observe the complex ways in which the computer has become integrated into the lives of these students. It is a knowledge representation device that extends well beyond the classroom and serves to integrate other knowledge and experiences with school-based learning. In the example above with Tod, the sixth-grader talks of how he and his father have formulated a plan to buy another printer so that Tod will be able to print out his assignments at home and not have to carry disks back and forth to school.

When a tape recorder was left on to record the subsequent conversation between Tod and his friend Jim, the two boys raised a host of issues about the computer and its uses and social meaning to them. Jim, for example, hoped that his brother would be put in the ACOT program for fourth-graders. If this happened, he reasoned, he could show his younger brother how to operate the computer so that their mother would not have to go through the computer training support program offered by the school.

In the next 10 minutes of recorded conversation these two boys raised the issue of computers no less than 8 additional times. Jim told the story of being in a clinic when he hurt himself and ended: "I said, 'I'll be glad when we leave the clinic, 'cause I wish I could go downstairs and work on the computer'. And that's what I like to do a lot is work on the computer." Jim then launched into another story about his cousin coming over to his home to play with his computer every Sunday. He was worried that the constant use would cause the unit to overheat and become damaged. This led him into a soliloquy on surge protectors ("a thing that have a lot of plugs on it, and it's gotta button right there that you turn it on with and turn it off..."). Jim then related a story about his friend's modem and what he did with it. Jim continued on returning, once again, to his enjoyment in playing with the computer after school. Then Jim and Tod discussed how smart one had to be in math, how happy they were to be in

ACOT, how good their teacher was, how she had reinforced their sense of being accomplished in math, and the like. They ended with a long paean to computers and ACOT in general and a comical debate about whether there were only seven ACOT classes in the whole world or just in the United States.

Teachers also related a large number of stories about how the computers become integrated with their students' family life. In two separate instances teachers reported that the computers at home became involved in literacy activities for the students' parents.

At this point we know very little about the social organization of computer-based skills and knowledge in the home and how this supports (or detracts from) its organization at school. We must also do serious ethnographic work on how different cultural and socio-economic groups in the United States organize learning in the home, integrate novelty, implement technology, value and promulgate behaviors like peer interaction, and so forth.

Finally, it is clear that there may be important teacher differences brought about by the introduction of computers. Most of the ACOT teachers we spoke with claimed that ACOT had affected their professional lives. They reported (of course) more work, but also more learning, perhaps more seat-of-the-pants teaching (that is, learning something themselves in the middle of a lesson with, presumably, consequences for their "in-flight" decision-making), and more team-based teaching. Certainly there is not much wonder in all of this given how nimbly students seem to master computer skills and how often teachers are thrown together in the same room where the academic ideal of colleagueship has a chance to be played out. But the real issue is whether this really makes a difference. And a difference to what? Is there an effect for teacher morale (and hence a diminution of subsequent burn-out), for curricular innovation, and/or for student learning?

The research strategy of choice, here, would be "before-during-after," intensive observational work. Another approach would be to videotape teachers during lessons and, using stimulated recall, talk to teachers about their interactive decision-making. Also we would need to do significant teacher interviews (see Gallimore, Dalton, & Tharp: 1986) to examine how teachers internalize new teaching scripts (if, in fact, they do).

Integrating Qualitative and Quantitative Approaches in the Assessment of ACOT: Opportunities and Risks

Of course, there are other questions we may use qualitative data to explore and other competing theoretical interests. Though one can complain about their use in atheoretical studies, the plain truth is that qualitative methods can be useful in an evaluation in an essentially "supportive" role. What do I mean? We can easily use observational data to tell "stories" about sites, answering questions like "how did this or that site get started?" "what kinds of curricular changes seem to be related to the introduction of these computers?" "what kinds of learnings do teachers most often report?" "how do children's attitudes about education or their self-esteem seem to change?" and so forth. Thus, we can not only provide tasteful site descriptions, but also we can provide observational data about specific features of these schools and their implementation of ACOT. As to the latter, we can generate an infinite list: teacher attitudes, student attitudes, peer interaction and tutoring, self-esteem, community spin-offs, parental expectations, student productivity, teaching styles, the student's sense of empowerment, the metaphors children use to explain their own learning, and so forth to mention only the most often cited ones.

We can also try to relate these items to student achievement. For example, in classrooms where there is a greater reliance on peer-tutoring do we find higher achievement scores?

In a kind of "sampler" approach we take a little bit of this, a little bit of that. Thus, we can try to use the data base we have, or can generate, to answer a limited set of questions about the social organization of knowledge and distributed learning in the ACOT environment. We may then try to provide some complementary data to help describe sites, answer essentially atheoretical questions, and possibly strive to link-up with the quantitative materials. If we do this, one must think carefully about which questions are worth addressing, what (limited) sets of qualitative data we therefore want, and how it is to be analyzed. None of this, really, is problematic or difficult to plot out. But, as in other cases in which qualitative data is the coal in someone else's engine, there will be little of its own magic or power. Typically, under such conditions, the evaluation is characterized by relatively superficial interview data, "factual" observations having to do with frequency counts, generalized "attitude" surveys, or the like. Qualitative analyses, and interpretive research, must be seen to have independent value.

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